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# PROJECT APOLLO
# END ITEM SPECIFICATION
# BOILERPLATE NUMBER 23A (U)

12 March 1965

NAS 9-150

Paragraph 4.2 Exhibit I

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**NORTH AMERICAN AVIATION, INC.**
**SPACE and INFORMATION SYSTEMS DIVISION**

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# TECHNICAL REPORT INDEX/ABSTRACT

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Project Apollo End Item Specification Boilerplate No. 23A

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**DESCRIPTIVE TERMS**

This document is an End Item Specification, Boilerplate Number 23A, a part of the Acceptance Data Package required under Exhibit I, paragraph 4.2 of the negotiated contract dated 25 January 1963.

**ABSTRACT**

This Specification defines the requirements for a simulated Apollo Spacecraft consisting of a Launch Escape System and a Command Module hereinafter referred to as Boilerplate Number 23A. Boilerplate Number 23A shall simulate a pad abort from a Saturn launch vehicle in the event of an emergency.



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FORM 131-V REV. 6-64

TABLE OF CONTENTS

TABLE OF CONTENTS (Con't)

TABLE OF CONTENTS (Cont'd)

# PROJECT APOLLO
# END ITEM SPECIFICATION
# BOILERPLATE NUMBER 23A

## 1. SCOPE

1.1 Scope.- This specification defines the requirements for a simulated Apollo spacecraft consisting of a Launch Escape System (LES), and a Command Module (CM), hereinafter referred to as Boilerplate Number 23A.

1.1.1 Specification Organization.- This specification is organized as a basic section only.

1.1.2 Mission.- The mission of Boilerplate Number 23A is to simulate a pad abort from a Saturn launch vehicle in the event of an emergency. The flight shall consist of the LES propelling the Launch Escape Vehicle (LEV) away from the launch pad and subsequent recovery system operation for safe CM landing.

## 2. APPLICABLE DOCUMENTS

The following documents, of the exact issue shown, shall form a part of this specification to the extent specified herein.

2.1 Project Documents

SPECIFICATIONS

Military

| | |
|---|---|
| MIL-L-6880B<br>25 August 1954 | Lubricating, Aircraft, General Specification for |

North American Aviation, Inc., Space & Information Systems Division (NAA/S&ID)

| | |
|---|---|
| SID 63-313<br>22 February 1965 | CSM Technical Specification, Block I |

STANDARDS

Military

| | |
|---|---|
| MIL-STD-130B<br>24 April 1962 | Identification Marking of U.S. Military Property |

2.2 <u>Precedence.-</u> The order of precedence in instance of conflicting requirements shall be as follows:

a. The Contract, NAS 9-150

b. This specification

c. Other documents referrenced herein

## 3. REQUIREMENTS

3.1 General.- The following paragraphs define the requirements for design, fabrication, assembly, and performance for Boilerplate Number 23A. Systems and subsystems development plan philosophy is reflected in the NAA/S&ID, Apollo Program Plan (see Section 6).

3.1.1 Weight.- Weight, center of gravity, and moments of inertia data for Boilerplate Number 23A shall be defined in the NAA/S&ID Actual Weight and Balance Report (see Section 6).

3.1.2 Materials.- Materials shall be compatible with design, weight, and load criteria.

3.1.3 Fabrication.- Structural design concepts of Boilerplate Number 23A emphasize employmentof proven manufacturing techniques and methods to the greatest possible extent. Maximum use shall be made of developed off-the-shelf components fabricated by dependable manufacturers.

3.1.4 Design Criteria.- Design criteria shall be in accordance with rational design principles as specified in Specification SID 63-313.

3.1.5 Electromagnetic Interference.- Electromagnetic interference control shall be invoked to preclude possibility of compromise of range safety or degradation of analytical data.

3.1.6 Environment.- The environmental design criteria for Boilerplate Number 23A shall be as specified in Specification SID 63-313.

3.1.7 Checkout Provisions.- Boilerplate Number 23A shall be designed with provisions for system and integrated systems checkout and test capabilities.

3.1.8 Interchangeability and Replaceability.- Mechanical and electrical interchangeability shall exist between like assemblies, subassemblies, and replaceable parts of operating subsystems (electronic, electrical, etc) regardless of the manufacturer or supplier. Non-operating subsystems such as structure need not comply with this requirement. Interchangeability for the purpose of this paragraph does not mean identity, but requires that a substitution of such like assemblies, subassemblies, and replaceable parts be easily effected without physical or electrical modifications to any part of the equipment or assemblies,including cabling, connectors, wiring, and mounting, and without resorting to selection; however, adjustment of variable resistors and trimmer capacitors may be made. In the design of the equipment, provisions shall be made for design tolerances sufficient to accommodate various sizes and characteristics of any one type of article, such as tubes, resistors, and other components having the limiting dimensions and characteristics set forth in the specification for the particular component involved without departure from the specified performance. Where matched pairs are required, they shall be interchangeable and identified as a matched pair or set.

3.1.9 Identification and Marking.- Specification MIL-STD-130 shall be considered as a reference guide in identification marking of equipment, assemblies, and parts.

3.1.10 Identification and Traceability.- Apollo identification and traceability shall be in accordance with the contractor's approved quality control plans.

3.1.11 Lubrication.- Lubrication of components, where required, shall be in accordance with the requirements of Specification MIL-L-6880. No petroleum-base lubricants shall be used. Lubricants shall be of the silicone base, flurolube, oxylude 702, and dry film type. Lubrication shall not cause any toxic or flammable substances to occur in the CM or in the environmental control system.

3.1.12 Reliability.- NAA/S&ID shall establish a reliability program in accordance with the provisions of Contract NAS 9-150.

3.2 Configuration.- The configuration of Boilerplate Number 23A is shown in Figure 1.

3.2.1 Launch Escape System (LES).- The LES shall consist of the following major components:

(a) Q-Ball assembly

(b) Ballast enclosure

(c) Pitch Control motor

(d) Canard system

(e) Tower jettison motor

(f) Launch escape motor

(g) Structural skirt

(h) Launch escape tower

(i) Boost protective cover

(j) LES electrical system

(k) LES pyrotechnic system

(l) LES umbilical system

(m) LES R and D instrumentation

(n) LES Tower - CM separation system

3.2.1.1 Q-Ball Assembly.- The Q-Ball Assembly which is located in the apex of the LES, shall be installed on Boilerplate Number 23A at the White Sands Missile Range (WSMR). A wire harness shall transmit the signals from the Q-Ball to the PAM/FM/FM telemetry system in the CM. (See 3.2.2.5.4 for component description and functional operation of the Q-Ball System).

3.2.1.2 Ballast Enclosure.- The ballast enclosure shall be constructed of stainless steel and shall be capable of housing up to 960 pounds of ballast, the pitch control motor, and the canard system.

3.2.1.3 Pitch Control Motor.- The pitch control motor shall be a solid propellant reaction motor 8.8-inches in diameter and 22-inches in length. The motor shall provide 1750 $\pm$ 32 pound-seconds total impulse in the minus Z direction, producing pitch about the Y axis in the minus Z direction which shall provide lateral displacement. The rocket motor shall be ignited by a pellet basket igniter which is initiated by two hotwire igniter cartridges.

3.2.1.4 Canard System.- The canard system shall be deployable and shall consist of two aerodynamic surfaces, an actuating system, stops, and locking devices. The canard system shall be designed to orient the blunt end of the launch escape vehicle forward to minimize tumbling following aborts from the pad to approximately 8,500 feet. The canards shall be hinged longitudinally on opposite sides of the LES ballast compartment. In the stowed position, the winged surfaces shall remain flush with the LES motor body and shall constitute a portion of the upper cylindrical conical sections of the ballast compartment. The canard system is shown in Figure 2.

3.2.1.5 Tower Jettison Motor.- The tower jettison motor shall be a solid propellant motor 55.6-inches in length and 26-inches in diameter. The motor shall have two fixed nozzles canted 30-degrees from the mean motor centerline. The resultant thrust axis shall be located approximately 4-degrees plus or minus 30-minutes from the mean motor centerline of the pitch plane. The jettison motor shall weigh approximately 534-pounds, (which includes the interstage structure) shall develop 33,000-pounds force of thrust and shall fire for 1.2-seconds. The rocket motor shall be ignited by a pyrogen type igniter which is initiated by two hotwire igniter cartridges.

3.2.1.6 Launch Escape Motor.- The launch escape motor shall be a solid propellant motor with four nozzles nominally canted 35-degrees from the mean motor centerline. The resultant thrust vector of 2-degrees 45-minutes plus or minus 15-minutes in the pitch plane shall be obtained by a difference in two opposite nozzle throat areas. The motor shall contain approximately 3200-pounds of solid propellant fuel and shall have a gross weight of approximately 4800-pounds. The motor shall be designed for a minimum of 515,000 LBF seconds total impulse. The average effective thrust developed during the first 2 seconds of firing shall be approximately 155,000-pounds force at 36,000 feet altitude and 70 degrees Fahrenheit temperature. The motor shall be ignited by a pyrogen type igniter which is initiated by two hotwire igniter cartridges. The motor shall have a burning time of about 3.5-seconds at nominal thrust and 70 degrees F with burnout at 8-seconds.

3.2.1.7 Structural Skirt.- A structural skirt assembly shall be utilized to mount the launch escape motor to the tower. The skirt shall be constructed of a forged ring with longerons welded to a shear skin that shall transfer uniform loads from the launch escape motor to four points at the launch escape tower legs. The structural skirt shall be bolted to the LES tower.

3.2.1.8 Launch Escape Tower.- The launch escape tower shall be a four-legged, truncated, retangular cross-sectioned, pyramid structure of welded tubular titanium alloy. The tower shall be 120-inches in length with a base 46-inches by 50 inches. The tower shall form the intermediate structure between the CM and the escape, jettison, and pitch control motors. Explosive bolts at the bottom of the tower shall attach the tower legs to the CM.

3.2.1.9 Boost Protective Cover.- The boost protective cover shall be used to completely enclose the conical portion of the CM. The forward part of the cover shall extend from the CM apex to station $X_c$ + 81 and shall be constructed of hard honeycomb fiberglass with an outer layer of ablative material. The cover shall be used to demonstrate the dynamic effects and the separation capabilities with the LES during an abort mission as defined in 3.3.1. The cover simulates the spacecraft cover in basic design, however, no provisions are made for the RCS orifices, window, or hatch provisions. A simulated hard structure over the rendezvous windows are incorporated in the covers. The individual covers shall be assembled in eight sections to allow access to the CM. The cover shall be attached with brackets to the LES tower legs and shall be jettisoned with the LES. The boost protective cover is shown in Figure 3.

3.2.1.10 LES Electrical System.- The LES electrical system shall consist of the following:

(a) LES electrical wiring harness

(b) LES hotwire initiators

(c) Launch escape tower sequencers

3.2.1.10.1 LES Electrical Wiring Harness.- Redundant wiring harnesses shall be bonded to the exterior of the launch escape motor and associated redundant harnesses shall be integral to the tower structure. The wiring harnesses shall provide the means of connecting the rocket motor and separation circuits with the sequence controllers and the tower sensor instruments with the communications equipment. Each harness shall have a breakaway type plug that shall permit the harness to be detached at the separation plane when the launch escape tower is jettisoned.

3.2.1.10.2 <u>LES Hotwire Igniter Cartridges</u>.- The LES hotwire igniter cartridges shall be electroexplosive (pyrotechnic) devices which shall ignite the launch escape, pitch control, and tower jettison motors. Similar devices shall detonate the explosive bolts which tie the tower and CM together. The igniters and firng circuits shall be redundant to ensure reliable activation of each function.

3.2.1.10.3 <u>Launch Escape Tower Sequencers</u>.- Two LES tower sequencers shall be installed on the underside of the structural skirt. The sequencers shall receive input signals from the mission sequencer and transmit electrical signals in proper sequence to (1) detonate the launch escape tower - CM attachment explosive bolts (2) energize the launch escape and pitch control motors and the tower jettison motor by igniting the motor igniters and (3) to detonate the thruster squibs (signal to mission sequencer transmitted through 0.4 second time delay relay) to jettison the apex forward compartment cover. The sequencers shall provide circuits for monitoring the functional status of critical control circuits by GSE during checkout operations. The sequencers shall be totally redundant for reliability.

3.2.1.11 <u>LES Pyrotechnic System</u>.- The LES pyrotechnic system shall consist of the following major components and shall be redundant to ensure reliable activation of each function:

(a) Pyrotechnic batteries

(b) Electrical wire busses

(c) Hotwire initiators

3.2.1.11.1 <u>Pyrotechnic Batteries</u>.- The four pyrotechnic batteries (2 each, backup) located in the CM, shall be the power source for supplying dc current to the pyrotechnic devices.

3.2.1.11.2 <u>Electrical Wire Busses</u>.- The electrical wire busses incorporated in the wiring harness, shall transmit current from the pyrotechnic batteries to the low resistance hotwire initiators.

3.2.1.11.3 <u>Hotwire Initiators</u>.- The low resistance hotwire initiators shall ignite the launch escape, pitch control, and tower jettison motors and detonate the explosive bolts which tie the tower and CM together.

3.2.1.12 <u>LES Umbilical System</u>.- The LES umbilical system shall provide means by which the LES and CM are linked electrically. Two electrical connectors shall join the LES-CM electrical systems. The connectors shall be located in the LES-CM separation plane adjacent to an escape tower leg well in the CM forward heat shield. The receptacle portion of the connectors shall be attached to the nearest tower leg by a lanyard. When the escape tower separates from the CM, the lanyard shall pull the plugs from the receptacles.

3.2.1.13 IES R and D Instrumentation.- The IES R and D instrumentation shall consist of the following:

(a) IES Q-Ball

(b) Accelerometers

(c) Chamber pressure transducers

(d) IES camera system

Data acquired by the measurement devices shall be transmitted to the R and D telemetry equipment by means of the electrical wiring harness for transmission to the ground station. Measurements shall also be obtained from the tower sequencers. Refer to Apollo Measurement Requirements Boilerplate Number 23A (see Section 6), for list of measurements and sensor locations. The component description and functional operation of the Q-Ball assembly is described in 3.2.2.5.4.

3.2.1.13.1 IES Camera System.- The IES tower camera system consists of a camera (with lens), protective case, control unit with inertia switch activated time delay mechanism, timing generator unit, battery power supply and interconnecting electrical cabling. Bracketry for mounting the camera assembly shall be furnished.

The 16mm high-speed cine camera shall be housed in a protective case mounted on the IES tower structural ring, viewing downward. The camera shall view the CM protective boost cover and IES engine flame impingement, and IES tower/CM separation sequence. System functions shall be sequenced by a control unit, start initiation by inertia switch activated delay timing mechanism.

3.2.1.14 IES Tower - CM Separation System.- The IES tower - CM separation system contains four explosive bolts that secure the tower to the CM. Hotwire initiators shall supply the current necessary to detonate the explosive device, which effect release of the tower. The hotwire initiators shall be energized by positive 28-volt dc signals received from the tower sequencers through the IES-CM umbilical. To accomplish IES-CM separation and launch escape tower jettison, the tower sequencers shall simultaneously apply detonation signals to the separation system hotwire initiators and energize the igniters of the launch escape and pitch control motors. Umbilical cables shall be parted by force on the lanyard-type disconnects when the separation occurs, and the tower assembly shall be propelled clear of the boilerplate trajectory.

3.2.2 Command Module.- The CM shall consist of the following:

(a) CM structure

(b) Earth landing system (ELS)

(c) Electrical power system (EPS)

(d) Abort sequencer

(e) R and D communications equipment

(f) R and D instrumentation

3.2.2.1 Command Module Structure.- The CM shall be of conical design, approximately 135-inches high and 154-inches in diameter at the base with a weight of approximately 11,000 pounds (on launch pad). The structure shall be fabricated from aluminum with a skin thickness of approximately 0.190-inch. Cork insulation shall be applied to the exterior skin of the CM as required to protect the aluminum skin of the CM as required from critical temperatures during boost and abort. Attach fittings shall be provided at the forward bulkhead to engage the launch escape tower. The configuration of the CM shall be similar to the ultimate spacecraft CM. The CM structure shall include the following:

(a) Cabin housing

   (1) Forward bulkhead and egress tube

   (2) Forward crew compartment

   (3) Aft crew compartment

(b) Heat shield structure

(c) Separation system

3.2.2.1.1 Cabin Housing.- The CM shell shall be constructed of aluminum alloy welded into two subassemblies, (1) the forward crew compartment and (2) the aft crew compartment. The subassemblies shall be bolted together and the aft skirt frames and skin shall be attached by mechanical fasteners.

3.2.2.1.1.1 Forward Bulkhead and Egress Tube.- The forward bulkhead structure shall consist of a double skin with riveted stiffeners. The closeout skin shall be attached to stiffeners by blind fasteners. The egress tube shall consist of a welded sheet tube of aluminum welded to the forward bulkhead. A cover plate shall be bolted to the top of the egress tube.

3.2.2.1.1.2 Forward Crew Compartment.- The forward crew compartment shall consist of multi-stiffeners welded to the outer skin. The stiffeners shall consist of four main longerons attached to the launch escape tower fittings in the forward bulkhead and terminate in the mid-ring splice joint at the aft end of the forward section of the crew compartment. Several secondary longerons shall be utilized for load transfer from the forward bulkhead to the mid-ring. The remaining stiffeners shall assist the skin in resisting airloads.

3.2.2.1.1.3 Aft Crew Compartment.- The aft section of the crew compartment shall consist of a sidewall with stiffeners, corresponding to those of the forward section of the crew compartment, from the mating aft section of the crew compartment mid-ring to the machined ring forging at the junction of the sidewall and the floor.

3.2.2.1.2 Apex Forward Compartment Heat Shield Cover.- The apex forward compartment heat shield cover structure shall form the forward section of the CM structure and shall consist of an aluminum alloy skin and stiffeners utilizing riveted and bolted construction. A light weight inner skin shall be used to ensure a smooth surface so that the forward compartment cover shall not interfere with the parachute bags or equipment upon ejection. The cover shall be jettisoned 0.4 seconds after tower separation. The nose cone shall ab aluminum.

3.2.2.1.2.1 Apex Forward Compartment Cover Heat Shield Attachment.- The apex forward compartment cover heat shield shall be fastened to the CM structure by two tension bolts located at the launch escape tower leg fittings. Separation will be obtained by four thrusters (ejectors) interconnected in diagonally opposing pairs thrusting against free piston rods that are attached to the upper ring of the heat shield. Each pair of thrusters is connected to an independent gas pressure source consisting of a breech and an electrically initiated gas producing cartridge.

3.2.2.1.3 Aft Heat Shield.- The aft compartment heat shield shall be attached at the spacecraft ablative mold line and shall form the outer, blunt section of the CM. It shall simulate the spacecraft heat shield and shall be fabricated of glass cloth laminations with an aluminum honeycomb core sandwiched between inner and outer surfaces. The heat shield shall be mounted to the CM lower structure ring by four attach fittings installed on the heat shield inner surface. Six hard compression pads (ball and socket design) shall be installed through the heat shield for positioning on the pad adapter (A14-013).

3.2.2.1.3.1 Access Hatch.- The main hatch shall provide access to the CM interior. The hatch shall be constructed of reinforced aluminum plate and shall be bolted into place. It shall be located in the CM sidewall over the head of the center couch position.

3.2.2.1.3.2 Access Doors.- Access doors shall be provided in the skirt structure for servicing the heat shield attach struts. Four openings shall be provided in the forward crew compartment structure, approximately 90-degrees apart, for telemetry antennas.

3.2.2.2 Earth Landing System (ELS).- The ELS shall consist of an ELS sequencer and a parachute subsystem, and shall be located in the apex forward compartment around the egress tube.

3.2.2.2.1 ELS Sequencer.- The ELS sequencer shall control dual drogue parachute deployment, dual drogue parachute disconnection, and pilot parachute deployment. The ELS sequencer shall consist of relays, baroswitches, and timing devices.

3.2.2.2.2 Parachute Subsystem.- The CM shall be equipped with a parachute subsystem designed to decelerate and safely land a CM weighing up to 11,000-pounds (after ejection of the apex forward compartment cover and chute deployment) following mission abort. The subsystems shall consist of:

(a) Two drogue parachute systems

(b) Three main landing parachute assemblies, including pilot parachute systems

(c) A vehicle harness assembly

3.2.2.2.2.1 Drogue Parachute System.- Each drogue parachute system shall consist of one each of the following:

(a) Drogue parachute

(b) Drogue parachute deployment bag

(c) Drogue parachute mortar assembly

(d) Drogue parachute riser

(e) Drogue mortar pyrotechnic cartridges.

3.2.2.2.2.1.1 Drogue Parachutes.- Two dual-conical-ribbon drogue parachutes shall be mortar deployed reefed for eight seconds, then disreefed. Drogue parachute shall be 13.7 feet in diameter and will exert a maximum total load of 20,000 pounds on the CM.

3.2.2.2.2.1.2 Drogue Parachute Deployment Bag.- The drogue parachute deployment bag shall enclose and protect the drogue parachutes and risers while contained in the drogue mortars and during ejection. The deployment bag shall control the parachute and risers to insure orderly deployment of the parachute into the airstream.

3.2.2.2.2.1.3 <u>Drogue Parachute Mortar Assemblies</u>.- The drogue parachute mortars shall contain a drogue parachute and riser packed in a deployment bag, and shall eject the package into the airstream to provide positive deployment of the drogue parachutes.

3.2.2.2.2.1.4 <u>Drogue Parachute Risers</u>.- The drogue parachute risers shall be of sufficient length to place the drogue parachute in a favorable position, with respect to the airstream around the CM.

3.2.2.2.2.1.5 <u>Drogue Mortar Pyrotechnic Cartridge</u>.- Drogue mortar pyrotechnic cartridges shall provide the necessary propulsive force to eject the drogue parachute package a sufficient distance to provide full deployment of the drogue parachute.

3.2.2.2.2.2 <u>Drogue Disconnect Assembly</u>.- The drogue disconnect assembly shall connect the drogue parachute risers to the CM. The disconnect assembly shall release the drogue parachute risers upon the signal from the sequencer control system.

3.2.2.2.2.3 <u>Main Landing Parachute Assembly</u>.- The main landing parachute assembly shall consist of three pilot parachute systems and three main parachute pack assemblies.

3.2.2.2.2.3.1 <u>Pilot Parachute System</u>.- The pilot parachute subsystem shall consist of the following:

(a) Pilot parachute

(b) Pilot parachute deployment bag

(c) Pilot parachute mortar assembly

(d) Pilot parachute mortar pyrotechnic cartridges

(e) Pilot parachute risers

3.2.2.2.2.3.1.1 <u>Pilot Parachute</u>.- The pilot parachute shall be capable of extracting and deploying main parachute.

3.2.2.2.2.3.1.2 <u>Pilot Parachute Deployment Bag</u>.- The pilot parachute deployment bag shall contain and protect the pilot parachute prior to, and during ejection from the pilot mortar. They shall also control the deployment of the pilot parachute riser and pilot parachute.

3.2.2.2.2.3.1.3 <u>Pilot Parachute Mortar Assembly</u>.- The pilot parachute mortar assembly shall contain and eject the pilot parachute upon signal from the sequence controller.

[redacted]

3.2.2.2.2.3.1.4 Pilot Parachute Mortar Pyrotechnic Cartridges.- The pilot parachute mortar pyrotechnic cartridges shall provide the propulsive force necessary to eject the pilot parachute and riser from the mortar to a distance sufficient to allow the pilot parachute to inflate and deploy the main parachute.

3.2.2.2.2.3.1.5 Pilot Parachute Riser.- The pilot parachute riser shall retain the pilot parachute during deployment and operation. The riser shall be of sufficient length to place the pilot parachute in a favorable position with respect to the airflow around the CM.

3.2.2.2.2.3.2 Main Parachute Pack Assembly.- The main parachute pack assembly shall consist of three main parachutes contained in separate packs. Each pack assembly shall consist of the following:

(a) One main parachute

(b) One main parachute deployment bag

(c) One main parachute riser

3.2.2.2.2.3.2.1 Main Parachute.- The main parachute shall be designed to operate in a cluster of three parachutes and to comply with the performance requirements of Boilerplate Number 23A. Dual reefing systems, each consisting of one reefing line and three cutters shall be incorporated in each main canopy to reduce the probability of premature disreef. Consideration shall be given to possibilities of inadvertent arming during parachute packing.

3.2.2.2.2.3.2.2 Main Parachute Deployment Bag.- The main parachute deployment bag shall contain and protect the individual main parachute and riser prior to and during extraction from the CM and shall ensure orderly deployment of the parachute and riser.

3.2.2.2.2.3.2.3 Main Parachute Riser.- The main parachute riser shall be of sufficient length to place the individual main parachute in a favorable position with respect the airflow around the CM.

3.2.2.2.2.3.3 Main Parachute Pack Retention Flap.- The main parachute pack retention flap shall retain the main parachute and vehicle harness prior to deployment.

3.2.2.2.2.3.4 Vehicle Harness Assembly.- The vehicle harness assembly shall attach to the four parachute attach fittings on the CM forward egress tube and extend to the main parachute confluence assembly. The distance from the parachute attach fitting plane to the confluence assembly shall be 70-inches measured along the centerline of the harness assembly. The harness assembly shall allow the CM to land at 5-degrees plus or minus 0.5-degree from the vertical.

[redacted]

3.2.2.3 Electrical Power System.- The electrical power system will consist of one 120-ampere hours and seven 5-ampere hours Eagle-Picher, silver oxide-zinc batteries. The 120-ampere hours battery will be connected to instrumentation busses A and B. Two 5-ampere hours batteries will be connected to separate pyrotechnic busses and two 5-ampere hours batteries will be the power source for each of the two separate logic busses controlling pyro circuits.

3.2.2.4 Abort/Mission Sequencer.- The abort/mission sequencer shall provide a sequenced abort mode that shall be initiated while Boilerplate Number 23A is on the launch pad. The sequencer shall include abort lockout relays, abort hot line relays, pyrotechnic firing relays, and time delay relays necessary to provide the function required for the abort mission. The sequenced events shall be as follows:

(a) Abort lock-out relay activate

1. LES logic busses armed

2. Activate abort hot line relay

3. LES pyro busses armed

(b) GSE pre-launch arming signals

(c) Lift-off

1. Abort lock-out relay deactivated

2. Abort hot line relays deactivated

3. LES logic busses activated (abort initiated)

4. Launch escape and pitch control motors fired

(d) Canard deployment

(11 seconds after abort initiation)

(e) LES and BPC jettison

(3 seconds after canard deployment)

(f) Forward heat shield jettison and ELS pyro bus armed

(0.4 second after LES jettison)

(g) Dual drogues deployed

(2 seconds after LES jettison)

(h) Drogues released, pilot parachutes deployed extracting the three main parachutes

(12 seconds after drogue deployment)

3.2.2.5 <u>Research and Development Communication (R and D) Equipment</u>.- The R and D equipment shall provide a means of acquiring data pertinent to the mission of Boilerplate Number 23A. Acquisition will be by means of on-board tape recorders and RF telemetry transmission. Refer to Figure 4 for R and D Equipment Block Diagram.

3.2.2.5.1 <u>RF Electronic Equipment</u>.- The RF telemetry equipment for Boilerplate Number 23A shall consist of an IRIG PAM/FM/FM system containing a power supply, sixteen subcarrier oscillators, one 90 x 10 commutator, one mixer, one transmitter, one five point calibrator, one RF power amplifier, and an antenna system. The telemetry transmitter will have a total power output of 10-watts.

3.2.2.5.2 <u>Data Equipment</u>.- The primary data gathering device shall be an onboard tape recorder. In addition to recording 90 x 10 commutator information and all T/M continuous channels, those measurements requiring high-frequency response will be tape recorded. The tape recorder unit will consist of a tape recorder and tape recorder electronics and a remote control box. Capacity will be 750-feet of 1-inch tape operated at 15-IPS with approximately 10-minutes recording time.

3.2.2.5.3 <u>Antenna Equipment</u>.- The R&D antenna system shall consist of a telemetry antenna system.

3.2.2.5.3.1 <u>Telemetry Antenna System</u>.- The R&D telemetry antenna system shall consist of four slot antennas. These antennas shall be located just below the separation line of the forebody apex section of the CM and shall be spaced approximately 90-degrees apart.

3.2.2.5.4 <u>Q-Ball System</u>.- Three differential pressure transducers with associated attachment fittings and electronic wiring shall form the NAA/S&ID furnished Q-Ball system. Data acquired from the Q-Ball shall include angle of attack, angle of sideslip, and dynamic ram pressures. The transducers shall be located in the LES nose cone and shall sense airflow direction and pressure through ports in the nose cone surface. The input voltage shall be approximately 28-volts dc. The transducers shall be capacitive-balanced with conversion of input power to 8-kilocycles. The output of the transducers will be proportional to the three differential pressures measured. The transducer outputs will be applied to the telemetry equipment after amplification and coversion of the outputs to direct current.

3.2.2.6 R&D Instrumentation.- A telemetry system shall provide means of data acquisition from Boilerplate Number 23A during flight. A telemetry station will be positioned on the ground for the flight. A PAM/FM/FM system will be used for telemetry communications. Telemetry antenna installation for the CM is shown in Figure 1.

3.2.2.6.1 R&D Instrumentation Equipment.- The instrumentation and instruments will consist of, but not be limited to, accelerometers and pressure transducers. These signal conditioning devices will shape the information received from the sensors into a modulation voltage for the subcarrier oscillators. The amplifier portion will have the capability of being remotely calibrated for both R (range -85 percent full scale) and Z (Zero =15 percent full scale). Refer to the Apollo Measurement Requirements Boilerplate 23A (see Section 6), for sensor locations.

3.3 Performance.- The LES will lift the CM off the pad adapter and translate the CM to a safe distance from the launch area. Design of the LES shall permit all resultant motion to be within the limits of human tolerance and provide satisfactory conditions for the deployment of the recovery ssytem.

3.3.1 Launch Abort Mission.- The flight plan for Boilerplate Number 23A shall consist of (1) abort from launch pad, (2) LEV turn-around, utilizing canards, (3) LES and forward heat shield jettison, and (4) recovery system operation.

Boilerplate Number 23A will be launched from the White Sands Missile Range at approximately 4000-feet above mean sea level. The flight path will be to the North with a launch elevation angle of 90-degrees, for a distance of approximately 5000-feet. The LEV shall consist of a spacecraft LES and a Boilerplate CM. A special adapter will be used as a base for the LEV. The abort shall be initiated by a land line signal from the blockhouse to the abort relay. Abort enable GSE will lockout this signal during ground operations, and will be deenergized during the countdown. The abort signal simultaneously ignites the launch escape and pitch control motors.

Eleven seconds after abort initiation, the canards will be deployed causing LEV turn-around to a main (aft) heat shield forward attitude. The apogee of the trajectory will be about 8,000-feet above mean sea level reference.

The 24,000 feet and 1,000 feet barometric switches will be closed out due to the altitude; therefore, three seconds after the canards are deployed, the LES including the BPC, will be jettisoned by the tower jettison motor. Four hundred milliseconds (0.4) after LES jettison, the apex cover thrusters will be fired, thereby jettisoning the forward heat shield.

Reefed dual drogue parachutes will be deployed two seconds after LES jettison to stabilize and decelerate the CM for main parachute deployment. The drogues will be disreefed eight seconds after deployment. Four seconds after disreefing the drogue parachutes will be released, and simultaneously the three pilot parachutes will be deployed. The pilot parachutes in turn will extract the three main parachutes, which will be inflated in the reefed condition to reduce opening shock. Eight seconds after line stretch, the main parachutes will be disreefed and fully inflated to establish a descent rate of 27 feet per second prior to touchdown. Landing will occur at approximately 1.5 minutes after abort initiation.

# 4. QUALITY ASSURANCE

4.1 General Quality Assurance Provisions.- The contractor (NAA/S&ID) shall be responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the contractor may utilize his own or any other inspection facilities and services acceptable to NASA. Inspection records of the examinations and tests shall be kept complete and available to NASA as specified in the contract.

4.2 Contractor's Quality Assurance Program.- The contractor shall establish a quality assurance program in accordance with the requirements of paragraph 6 of Exhibit 1 of the contract. Inspections and tests to determine conformance of Boilerplate Number 23A to contract and specification requirements shall be conducted prior to submission of the article to the NASA for acceptance.

4.2.1 Reliability Data.- The contractor shall act as a test historian and accumulate applicable data on spacecraft tests, plans, and performance from preparation to delivery. The data shall be used in qualitative and quantitive assessments of reliability and performance of each system, and of the ultimate spacecraft. This data, together with other appropriate data, such as acceptance data, shall integrated with that accumulated from prior tests to form assessments. Thus, a probability of success may be provided for any given phase. The reliability data may also be compared with program objectives in order to assure that these have been attained.

4.3 Examination.- Each assembly and all major components submitted for acceptance shall be subjected to a visual examination to determine conformance to materials, design, construction, dimensions, color and finish, product marking, and workmanship. (See paragraphs 2, 4.1, and 4.2).

4.3.1 Components.- The contractor shall ascertain that, prior to assembly, all parts, components, assemblies, and systems procured under separate specifications or drawings have been inspected, tested and accepted in accordance with their respective specifications or drawings.

4.4 Tests.- Each assembly, major component, and system submitted for acceptance shall be subjected to performance tests. The electromagnetic interference control is defined in the Electromagnetic Compatibility Test for Boilerplate Number 23A (see Section 6).

## 5. PREPARATION FOR DELIVERY

5.1 Preservation, Packaging, and Packing.- Preservation, packaging, and packing provisions shall not be applicable for Boilerplate Number 23A.

## 6. NOTES

6.1 Reference Documents.- The following documents are intended for information purposes only and do not constitute a part of this specification.

| | |
|---|---|
| SID 63-574<br>16 April 1965 | Apollo Measurement Requirements<br>Boilerplate Number 23A |
| SID 65-29-1<br>19 March 1965 | Vehicle Test Plan, Apollo Mission<br>PA-2 (BP23A) |
| SID 63-143-17<br>15 June 1965 | Actual, Weight and Balance<br>Report, Boilerplate Stack No. 23A |
| SID 62-223<br>28 November 1962 | Apollo Program Plan |
| MA0201-0543<br>21 July 1964 | Electromagnetic Compatibility<br>Test for Boilerplate Number 23A |

[redacted]

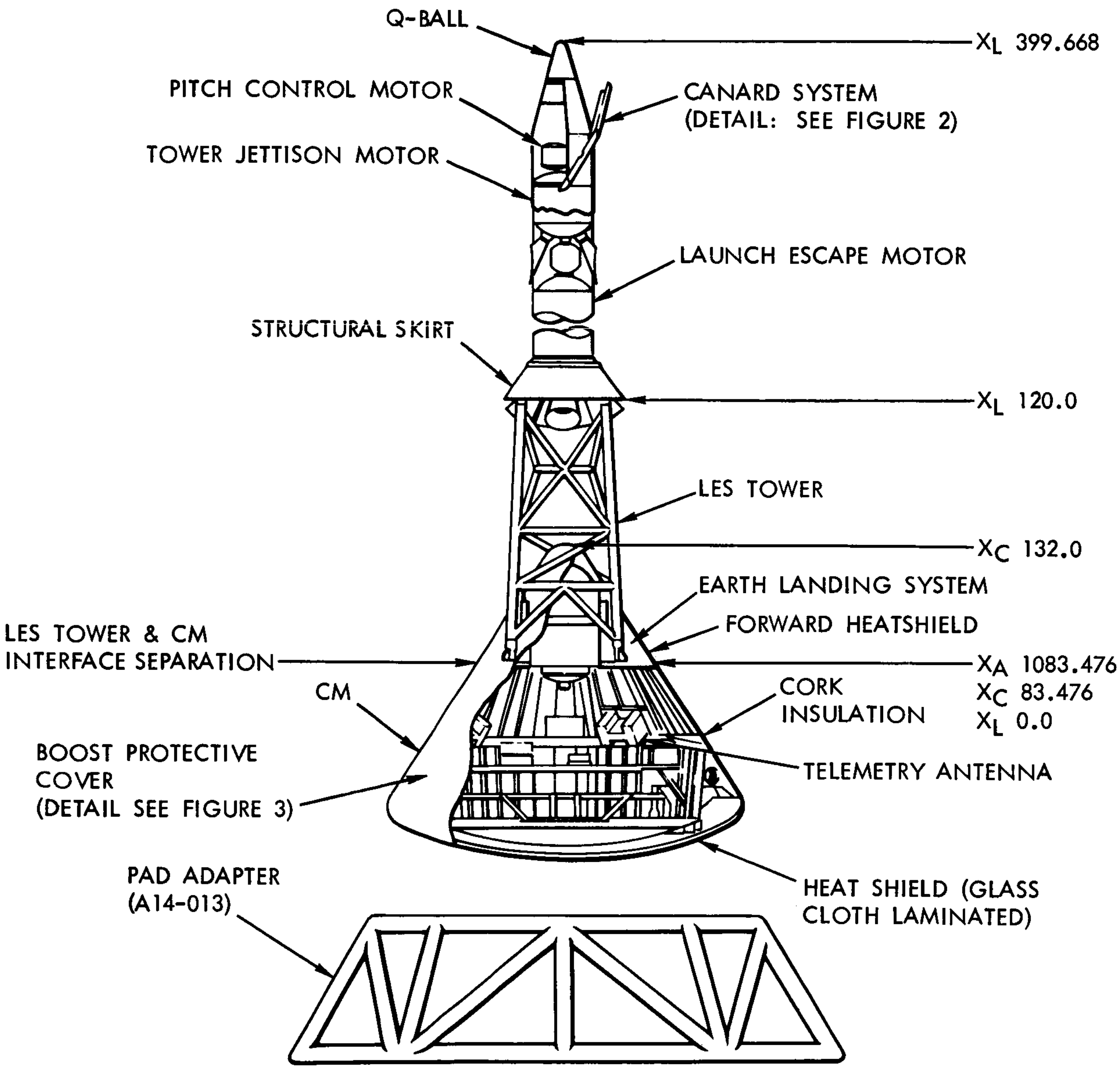


Figure 1. Configuration, Boilerplate No. 23A.



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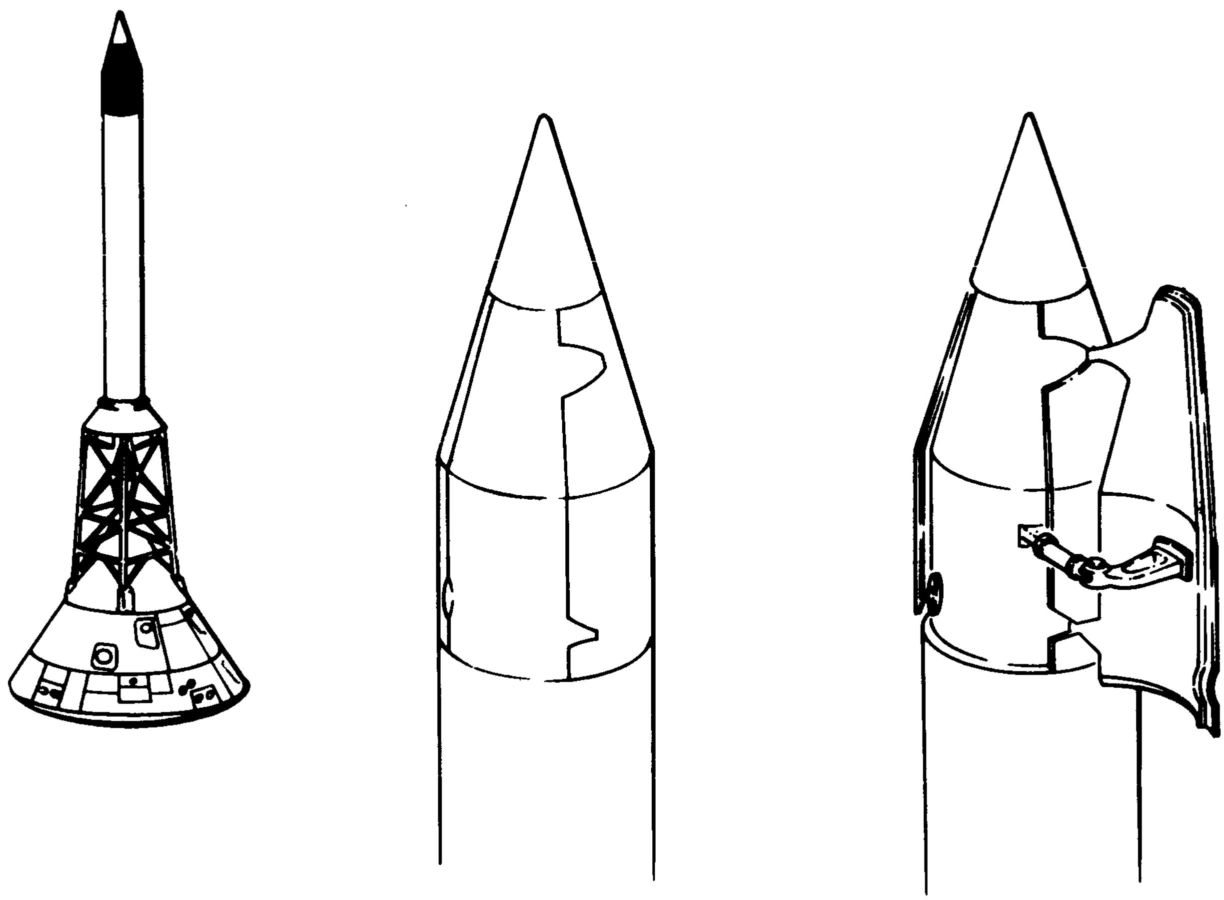

Figure 2. Canard System

[redacted]

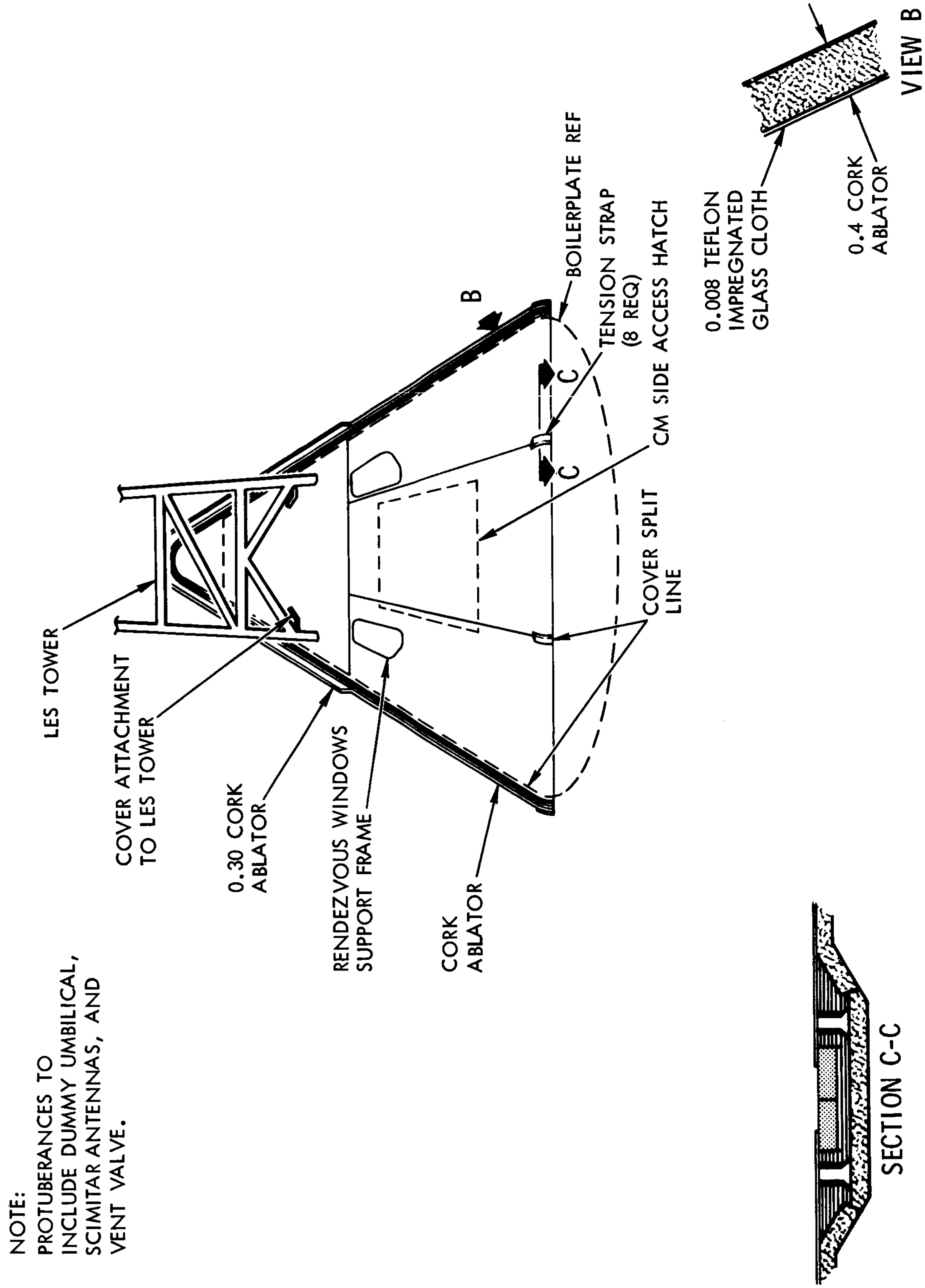


Figure 3. Boost Protective Cover



[redacted]

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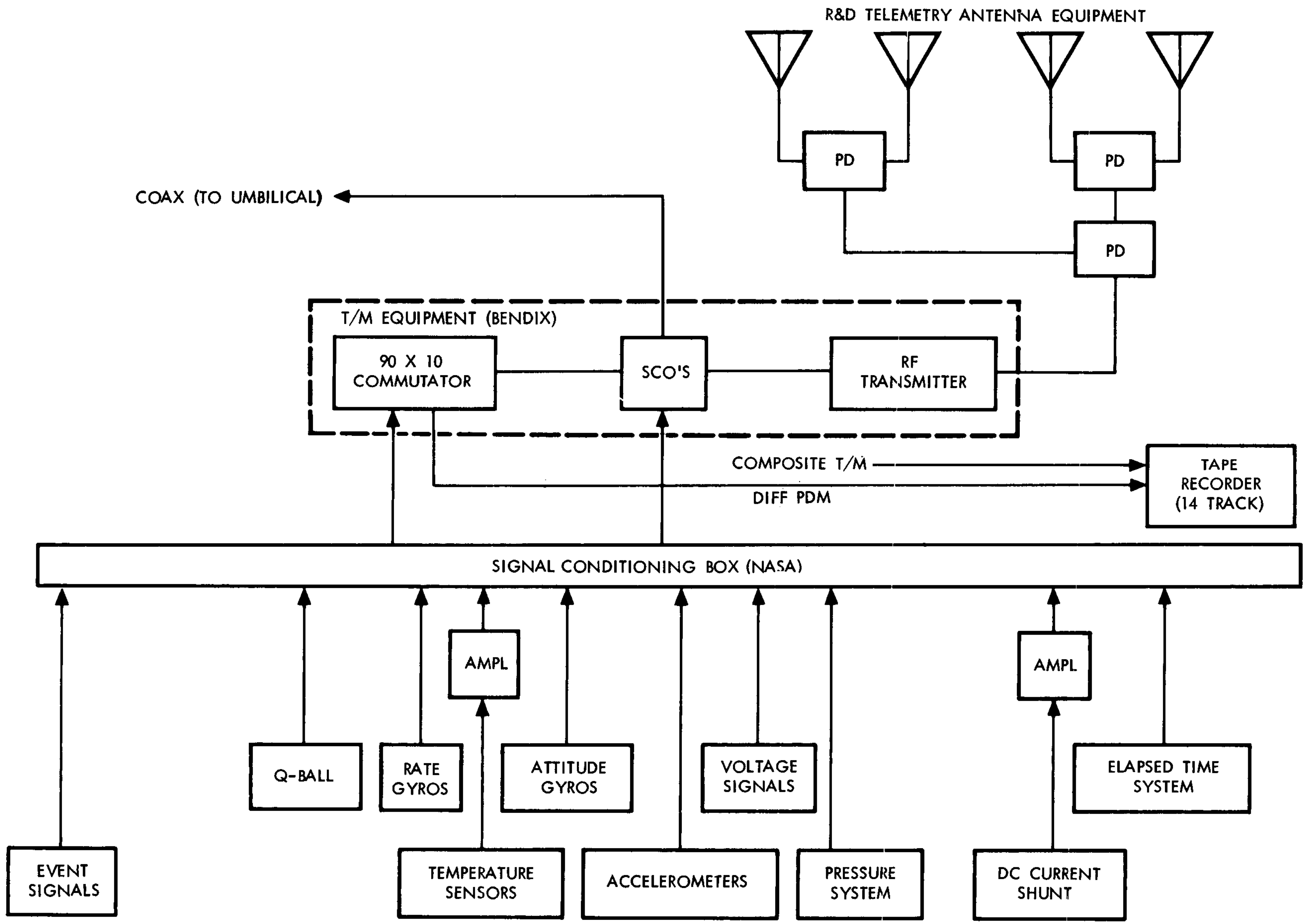


Figure 4. Instrumentation Block Diagram, Boilerplate No. 23A



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